Space Weather Technical Forecast

Issued on Thursday, 15 August 2024 at 13:29 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-class flares expected, a chance of X-class flares. G1-G2 Minor to Moderate storms on day 3 (17 Aug) due to CME arrival.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with three M-class flares, peaking M5.3 at 14/1549 UTC from a region just over the eastern limb that is just about becoming visible. There are ten regions on the visible disc, with the most notable being AR3784 in the north-centre, which is a moderately sized compact region with a complex magnetic structure, including a strong delta configuration and an east-west inversion line. Umbral area of the spot has increased, especially within the delta spot, along with some small surrounding spots emerging. Elsewhere AR3780 remains a large region in the southeast, but with some apparent weakening, although this could be due to the increasing viewing angle.

No Earth-directed CMEs were observed leaving the Sun in this period.

Solar Wind / Geomagnetic Activity: Mainly slow wind conditions were observed, although some increased magnetic strength perhaps hinted at some transient influence. Solar wind speeds, observed by ACE at L1, eased from slightly elevated to background, from 400 km/s to below 350km/s. Density was around average. The Interplanetary Magnetic Field, Bt ranged from Weak to Moderate, from 5-10nT, with the main strength between 14/2030-15/0630 UTC. The north-south component, Bz, reached minimum of -5nT around 14/2030 UTC before rotating to be persistent positive thereafter, with maximum 9nT. Phi angle generally negative (towards the Sun). Geomagnetic activity was mostly Quiet, but Unsettled 14/2100-15/0000 UTC (Kp 0-3).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 remained at background below the S1 Minor Radiation Storm threshold. High energy electron flux (greater than 2MeV) observed at GOES16 was at background. The 24-hour fluence was below the Active threshold, with 2.72e6 integrated pfu observed at 15/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High solar activity is forecast, with M-class flares expected and a chance X-class flares. There is slight chance of an isolated X10+ flare from AR3784 (R4-R5 Blackout).

Solar Wind /Geomagnetic Activity: A faint, partial halo CME occurred due to the X1.1 flare at 14/0640UTC, and is forecast to arrive at Earth day 3 (17 Aug). The strength of any impact is low confidence however, with the main geomagnetic activity likely with any subsequent magnetic cloud. This has the potential to be further enhanced by the fast wind of CH58/- on the north-disc, however this is most likely to remain north of Earth. Mainly Quiet geomagnetic activity at first is expected to become Active to G1/G2 Minor to Moderate Storm on day 3 (17 Aug) due to any CME arrival, with a slight chance of reaching G3 Strong Storm. Activity then easing day 4 (18 Aug).

Energetic Particles / Solar Radiation: High energy proton flux is most likely to remain at background, but with a chance of rising in response to any notable flares. This gives a chance of reaching the S1 Minor Solar radiation storm level, and perhaps towards the S3 Strong Solar Radiation Storm threshold if any significant flares of AR3784 were to occur. The high energy

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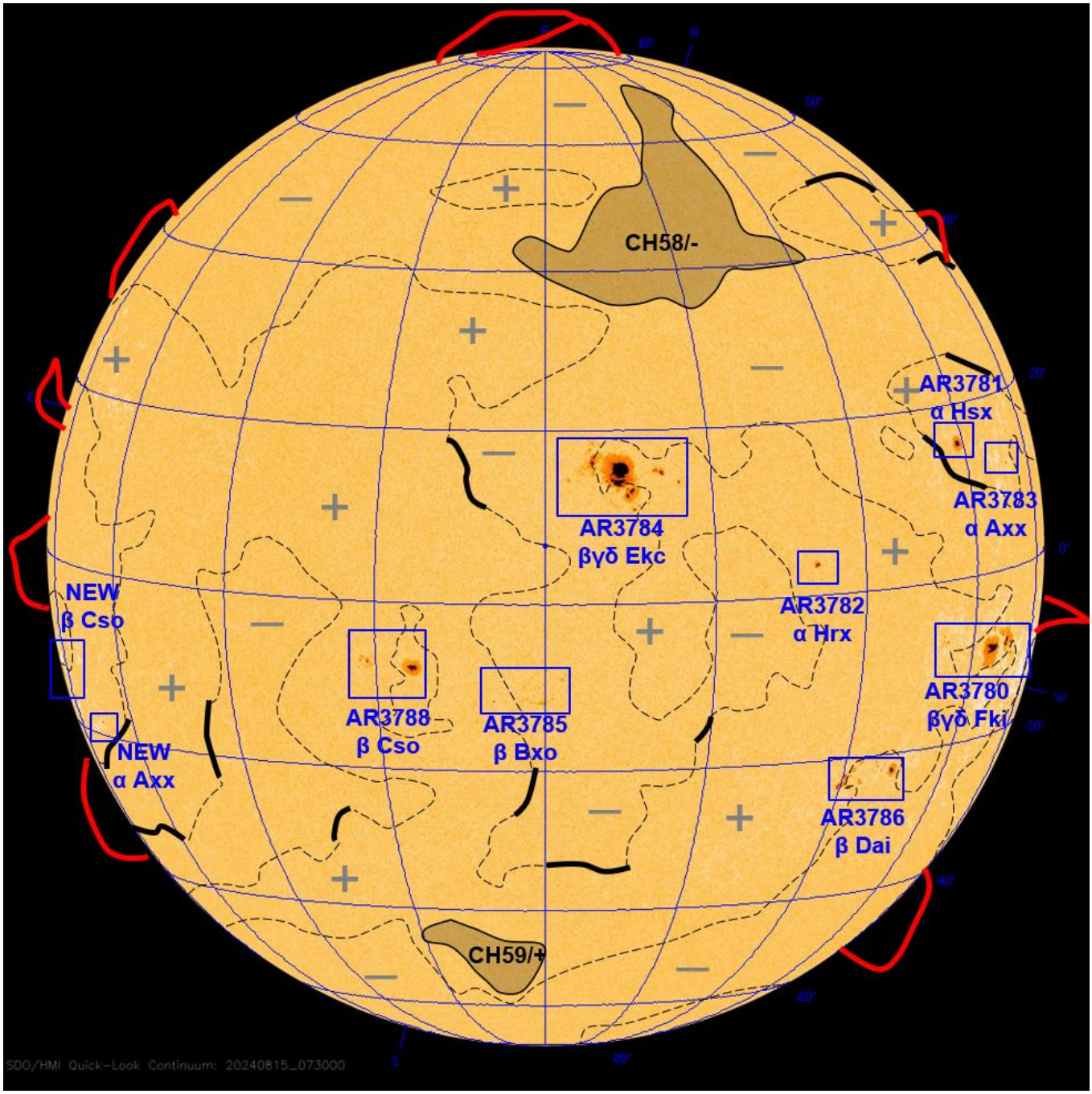
electron flux is forecast to be mostly at background with the associated 24-hour fluence remaining below the Active threshold (1e8 integrated pfu).

Figure 1. Solar Analysis Valid 15/0800.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A faint, partial halo CME associated with the X1.1 flare at 14/0640UTC has been assessed as having an Earth-directed component, likely arriving at Earth on day 3 (17 Aug), however, confidence is low. Given the relatively slow speed of the CME, the initial impact may be rather limited, with the majority of the geomagnetic activity most likely with the subsequent magnetic cloud.

While the fast wind from negative polarity coronal hole 58 is most likely to pass north of the Earth-Sun line, there is also some potential for an arrival alongside or shortly after the CME, on day 3 (17 Aug). This may further enhance any geomagnetic activity, however confidence is low as this recurrent feature did not connect with Earth on the previous rotation and also remains north of Earth on MOSWOC Enlil.

Geomagnetic activity is expected to be mainly Quiet, until the arrival of the CME on day 3 (17 Aug). G1-G2/Minor-Moderate storms are likely, with a slight chance of G3/Strong storm storms. These conditions continuing into day 4 (18 Aug), before easing through the day.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	10	70	40
Strong	G3	No	1	1	15	5
Severe	G4	No	1	1	2	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
14/1400	Partial	X1.1 flare	AR3784	610 km/s	17/0800 UTC -6hr, +12 hr	*

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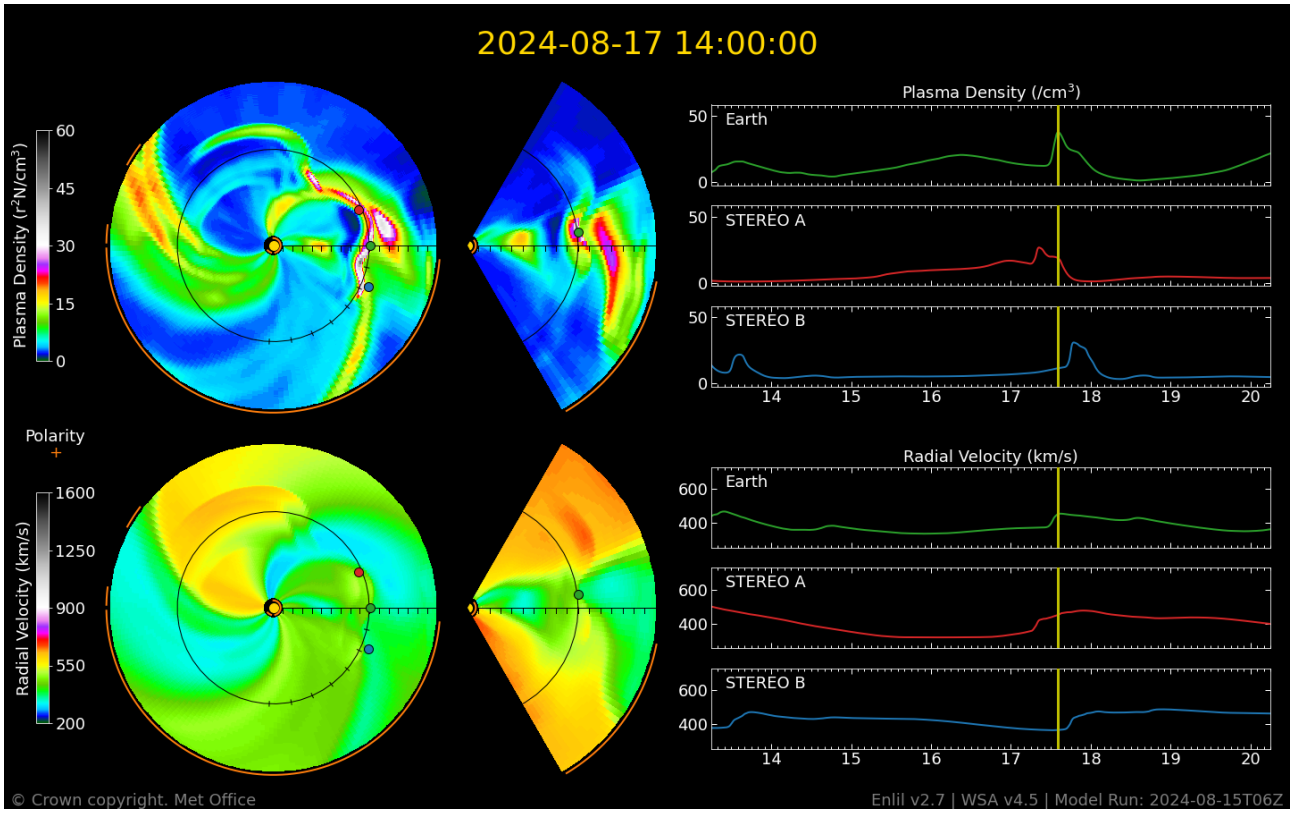
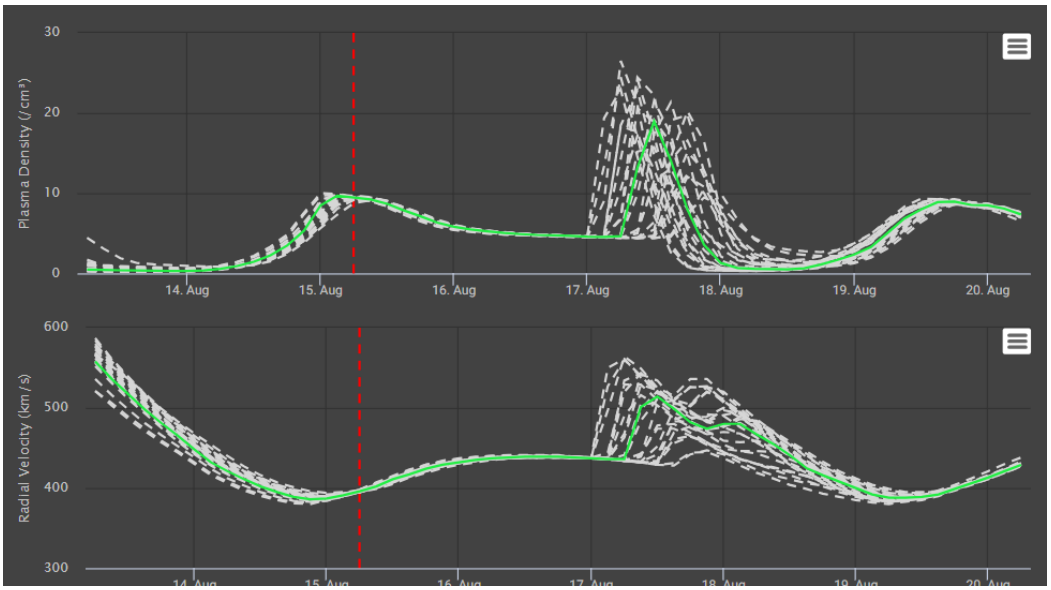
Figure 2: Enlil and ensemble





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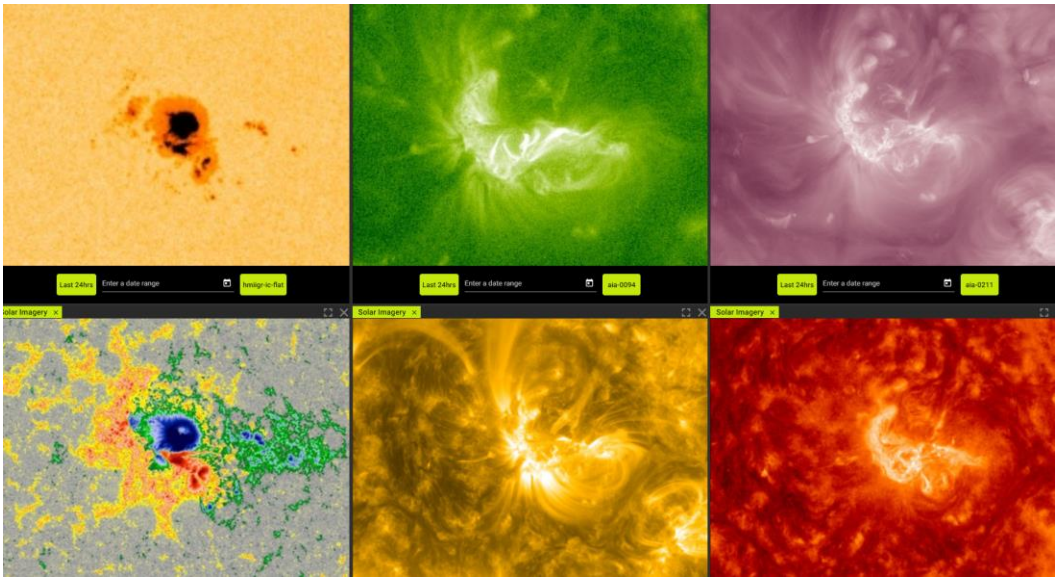
Radio Blackouts - X-Ray Flares:

Moderate to High activity, with further M-class flares expected and a chance of X-class flares. There is also slight chance of rising to Very High, due to AR3784 in the north-centre disc.

This is a moderately sized, but compact and magnetically strong sunspot region that was the source of an X-class flare on 14 Aug. The main positive leader spot has seen ongoing growth since this flare, with a further strong negative polarity spot developing along its southern edge. These both have strong umbrae and are arranged in a north-south orientation that is likely leading to shear across its magnetic field lines. Ongoing growth is also evident in surrounding small spots. This region has a similar appearance to other regions that have produced X10+ flares during previous solar cycles, and consequently brings a similar risk.
AR3780 in the southwest also brings a notable flare risk, although this region is becoming harder to assess as it approaches the southeast limb. Some apparent weakening may be due to this increasing viewing angle. The only other notable growth is from AR3786 in the southwest, however this remains a smaller and simpler spot. There is also a further region rotating onto the eastern limb, which was the source of a recent M5.3 flare, and further flares are likely possible from this location.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	75	75	75
Very Active	R3 to R5 X Class	No	40	40	30	20

Figure 3: SDO imagery of AR3784



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Solar Radiation Storms - (High Energy Protons):

High energy proton flux, as observed by GOES-18 is at background and most likely to persist at this level. Notable flares will bring the potential for proton counts to rise, with the most likely source AR3784 in the north-centre disc, with this potential increasing as this region moves across the western disc. The sunspots approaching or just over the western limb, including AR3780 and AR3777, also bring a potential for proton productive flares, however this risk will reduce later in the period as these move further onto the far-side.

Overall, there is a chance of reaching the S1-level, and if any significant flare occurs there is a slight chance of reaching the S3 threshold.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	25	30	30	30
Very Active	**≥ S3 ***	No	5	5	5	5
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux, as observed by GOES-16, is currently at background. The Strong and Severe geomagnetic storming on 12 Aug likely increased the see electron flux at lower orbital shells, and there is still a potential for a response at GEO as this flux moves outward. Any increase is likely to be rather subdued, however, likely peaking at Moderate at diurnal maximum, and may not be observable much above background.

The associated 24hr electron fluence is therefore currently expected to remain below Active (1e8 integrated pfu) levels throughout, with MOSWOC REFM providing good guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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